

Feliz cumpleaños, 21 years for the Beni Anaconda, *Eunectes beniensis* (Dirksen, 2002) (Serpentes, Boidae): an update of voucher specimens, species' distribution, and clarification of locality data of type specimens

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Abstract. Little information for *Eunectes beniensis* (Dirksen, 2002) (Serpentes, Boidae) exists in the scientific literature and museum data. We review the natural history, diet, reproduction, distribution of this species and discuss its identifying characteristics. We present new records and discuss the species' distribution in Bolivia. As reported in the previous literature, the geographic locality data of the holotype and paratypes are incorrect. We report corrected data for these specimens and update knowledge of the species' distributional status and natural history by summarizing novel and existing data from the entirety of this species' known range. We provide a distribution map based on vouchered museum specimens.

Keywords. Amazon, Bolivia, Neotropics, snake

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Introduction

The genus *Eunectes* Wagler, 1830 is a group of large, semiaquatic, booid snakes (Serpentes, Boidae) composed of four species, whose combined range extends from northern South America to Argentina (Henderson et al. 1995; Wallach et al. 2014; Reynolds et al. 2018). *Eunectes beniensis* (Dirksen, 2002), *E. murinus* (Linnaeus, 1758), and *E. notaeus* (Cope, 1862) are all known to occur in Bolivia (Dirksen 2002; Wallach et al. 2014; Reynolds et al. 2018; Uetz et al. 2022). *Eunectes murinus* (Green Anaconda) was described over two centuries ago and has been considered a single species broadly

distributed throughout many South American biomes (Peters and Orejas-Miranda 1970; Henderson et al. 1995; McDiarmid et al. 1999; Nogueira et al. 2019). *Eunectes notaeus* (Yellow Anaconda) occurs in the Paraguay river drainage, from the Pantanal Region in southeastern Bolivia, Paraguay, and Brazil, to northeastern Argentina (Henderson et al. 1995; Dirksen 2002; Waller et al. 2007; Kershaw et al. 2013). During a revision of the genus, *E. beniensis* was separated from *E. murinus* and *E. notaeus* as a new, distinct species based on ventral and dorsal scale counts, contact between suboculars and supralabials, head stripe pattern, pattern of body marking, and coloration (Dirksen 2002; Dirksen and Böhme

2005). Recently, Tarkhnishvili et al. (2022) completed a molecular analysis of the genus *Eunectes* that supported two distinct evolutionary lineages; one lineage consists of only *E. murinus* and is genetically divergent from the other group containing three species (*E. deschauenseei*, *E. beniensis*, and *E. notaeus*), which are all more closely related incipient species (but morphologically distinct) putatively maintained by geographic isolation.

There are limited information and data regarding the natural history, diet, and reproduction of *E. beniensis* (i.e. as compared to other species of *Eunectes*). Dirksen and Böhme (2005) and Embert (2009) acknowledged the overall lack of information but commented that *E. beniensis* will probably be generally similar to other species of *Eunectes*. Dirksen and Böhme (2005) commented on the diurnal activity and protective balling-posture behavior. Embert (2009) listed habitat as Beni flooded savannas and parts of southern Amazonia. Additionally, Embert (2009) also commented on the probability of reproductive activity (i.e. September–October with birth in April–May) but failed to provide any supportive data. De la Quintana et al. (2017) used radio telemetry to study home range and habitat use of nine radio-tagged individuals and reported the species' preference for flooded savannas and swamps and apparent avoidance of forest and agricultural areas (i.e. rice fields). In a recent comprehensive literature review comparing documented prey of *Eunectes* species, Thomas and Allain (2021) listed only one citation for *E. beniensis* (De la Quintana et al. 2011), reporting a case of cannibalism. This overall lack of information on *E. beniensis* is possibly, in part, due to the species' historical inclusion and confusion with *E. murinus*. In addition, relatively few specimens have been collected from Bolivia and deposited in museums as voucher materials; this could be due partially to the species' large adult size and difficulties associated with capture, transport, and preservation of specimens. For example, in some cases only the head or the skin with head and tail was preserved.

The geographic distribution and natural history of *E. beniensis* has been poorly documented and studied since its original description in 2002. Therefore, to improve knowledge of this species, our objectives are to: 1) describe several new voucher specimens of *E. beniensis* collected from Bolivia in the departments of Beni and Santa Cruz, 2) present a list of specimens that we were able to locate and verify in museum collections, 3) report on numerous errors in the geographic locality data of the holotype and paratypes of *E. beniensis* and correct these data, 4) discuss identifying characteristics not previously reported for *E. beniensis*, and 5) present and discuss the species' distribution based on the results of the aforementioned objectives.

Methods

Scale counts, scutellation, and terminology follow Dowling (1951) and Peters (1964). Head-scale counts (i.e. loreal, preocular, postocular, supralabials, infralabials,

and temporal) were reported on one side only. Dorsal scale row counts were taken at three standardized locations: head length behind occiput, midbody, and head length anterior to cloaca; these are separated by a slash (/). Measurements were taken using a flexible ruler to the nearest millimeter. Weight of the specimens in kilograms (kg) was determined using a CK model (12.5 kg) spring balance. Sex was determined by the probe method following McDiarmid et al. (2012) and confirmed by injection following Simmons (2002). Specimen identification was determined by comparing and analyzing meristic data, morphometrics, coloration, figures, photographs, and descriptions following Dirksen (2002) and Dirksen and Böhme (2005) for *Eunectes beniensis*. Specimens were fixed with a 10% formalin solution and preserved in a 70% ethanol solution. Geographic coordinates in decimal degrees (rounded to four decimal places) were determined using a Garmin etrex GPS receiver using the WGS84 datum. For specimens where coordinates were estimated from a map using a general locality name, decimal degrees were limited to three decimal places. Specimens are associated with specific coordinates where data permit (unless otherwise noted). The record and distribution map were prepared using ArcMap v. 10.1 (ArcGIS software).

A comprehensive search for voucher specimen information consisted of reviewing published scientific papers, journals, books, and government reports. Online databases, including VertNet (<https://vnet.org>), ARCTOS (<https://arctosdb.org/>), Global Biodiversity Information Facility (GBIF, <https://www.gbif.org/>), and SpeciesLink (<https://splink.cria.org.br/>) were also searched. In addition, natural history museums were contacted for voucher specimen verification and information. All records were rechecked for taxonomy and georeferencing precision.

For records published with only a textual description of the location, we determined the latitude and longitude coordinates using Google Earth. We defined coordinates based on the approximate center of the named locations for these specimens with the centroid coordinates 0.5 km in relation to the perimeter.

The newly collected specimens were deposited in the herpetology collection of the Centro de Investigación de Recursos Acuáticos in Trinidad, Beni, Bolivia. Research was approved by the Texas A&M University-Kingsville (#2018-05-22) Animal Care and Use Committee and permitted by the Dirección General de Biodiversidad y Áreas Protegidas Bolivia (permit #0120/2022).

Abbreviations and codes for museum collections are as follows: Colección de Historia Natural de Herpetología, Centro de Investigación de Recursos Acuáticos, Universidad Autónoma del Beni José Ballivián (CIRA); American Museum of Natural History (AMNH); University of Michigan Museum of Zoology (UMMZ); Colección Boliviana de Fauna, La Paz, Bolivia (CBF); Museo de Historia Natural “Noel Kempff Mercado,” Santa Cruz de la Sierra, Bolivia is coded as NKR in

Dirksen (2002) and Dirksen and Böhme (2005); however, Sabaj (2020) it is listed as MNK.

Results

Eunectes beniensis (Dirksen, 2002)

New materials examined. BOLIVIA – Beni • Mamoré province; ca. 32.0 road km SW of community of San Ramón; 13.4459°S, 064.8246°W; 30 June 2022, 15:15 h; C. Eversole, R. Powell, L. Rivas leg.; found crossing road (Ruta Nacional 9) between wetland areas; snout–vent length 174.2 cm, tail length 33.0 cm, live weight 4.55 kg, 1 adult ♀, CIRA-945 (Fig. 1) • Cercado province, city of Trinidad; 14.8296°S, 064.9093°W; April 1999, 10:30 h; L. Torres, A. Parada, P. Vaca, F. Soletto leg.; found near SE corner of Jorge Henrich Arauz Airport in a ditch in Barrio Chaparral area; snout–vent length 186.2 cm, tail length 32.0 cm; 1 adult, sex undetermined, CIRA-852 • Cercado province, Laguna Suárez area, ca. 4.0 km SE of city of Trinidad; 14.8750°S, 064.8745°W; 16 May 2012, 06:30 h; A. Parada, R. Cholima, T. Yunoki, C. Oliva leg.; found dead on banks near main entrance to lake; snout–vent length 66.0 cm; tail length 10.8 cm, 1 adult, sex undetermined, CIRA-966.

Identification. The meristic data and description from accounts by Dirksen (2002) and Dirksen and Böhme (2005) for *E. beniensis* are augmented with additional information based on our examination of the newly collected specimens. *Eunectes beniensis* is characterized by having 36–39/48–51/30–33 dorsal scales (unkeeled, with no apical pits), 219–230 narrow ventral

scales, 54–59 subcaudal scales, undivided cloacal scale, one loreal scale, one preocular scale, three postocular scales, two or three subocular scales in contact with supralabials (Fig. 2), 14 or 15 supralabial scales, 17–19 infralabial scales, temporal scales numerous and variable, and chin-shields not present. See Table 1 for comparison of meristic data of new specimens.

Color, pattern, and description: stout-bodied with head large and slightly differentiated from neck. Dorsum ground color olive-brown with 87–126 large, dorsal, black blotches, separated by three or four scales with smaller, solid, roundish or irregularly shaped, black blotches throughout flank region. Head color same as dorsum, with five distinct, black, longitudinal stripes, two or three scales wide (Fig. 3), one median dorsal, one pair of dorsolateral, and one pair of lateral stripes; lateral stripe starting from posterior eye to slightly past mouth. Eyes medium-sized, slightly dorsal, with elliptical pupil and brown to bronze iris. Ventral color yellow, with numerous black irregular marks throughout and sometimes forming interrupted longitudinal shapes.

Discussion

Past literature has reported erroneous geographic locality data for both the holotype and paratypes of *Eunectes beniensis*. These data have been reviewed, corrected, and augmented with new specimens to construct a distributional map for the species.

Geographic coordinates of the holotype and paratypes. The location data for the holotype specimen



Figure 1. *Eunectes beniensis* (CIRA-945), adult female, collected in Bolivia, department of Beni. This individual had a snout–vent length of 174.2 cm and a tail length of 33.0 cm. Photograph: CBE, RLP, and LRR.

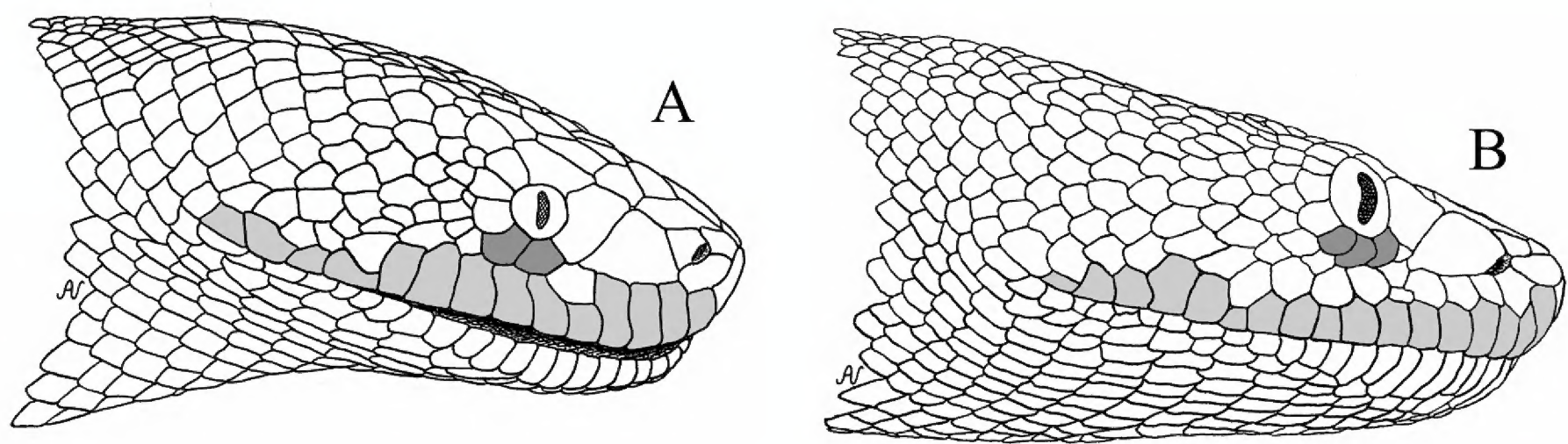


Figure 2. Drawing of lateral aspect of head of (A) *Eunectes beniensis*, female (CIRA-945) and (B) *E. murinus*, male (CIRA- 534) showing subocular scales (dark gray) and supralabial scales (light gray). Subocular scales in *E. beniensis* are in contact with supralabials in contrast to *E. murinus* which has an additional row of scales between the suboculars and supralabials. Illustration: AVC.

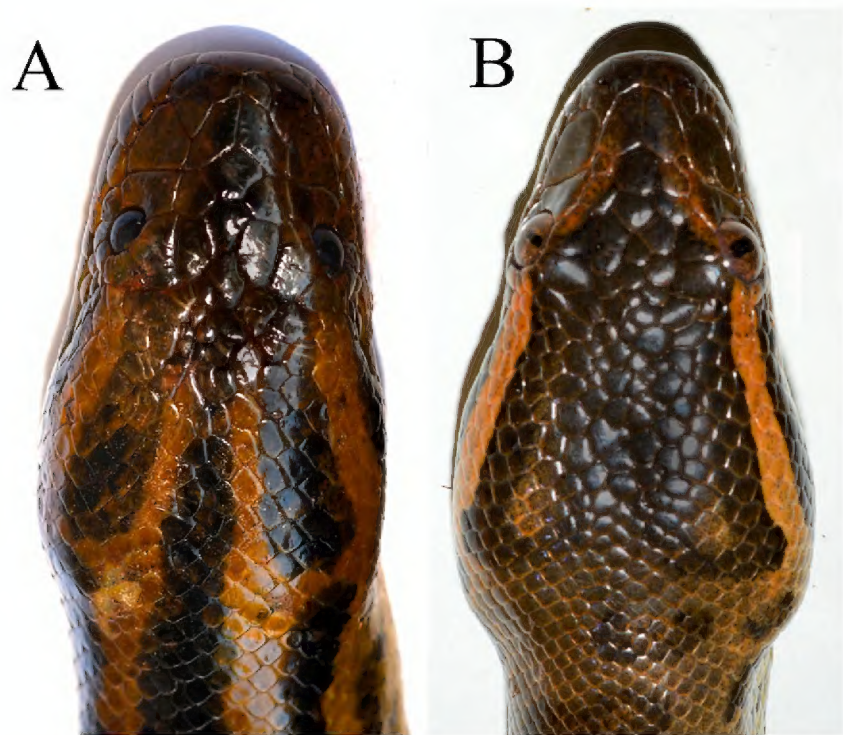


Figure 3. Photograph of head (dorsal view) of (A) *Eunectes beniensis*, female (CIRA-945) and (B) *E. murinus*, male (CIRA- 534). *Eunectes beniensis* has five distinct, black, longitudinal head stripes; one median dorsal, one pair of dorsolateral, and one pair of lateral stripes in contrast to *E. murinus* which has a pair of lateral head stripes and a large, dorsal, dark olive-brownish triangle (thickly bordered in black) with apex toward snout. Photographs: CBE, RLP, and LRR.

(AMNH 10924) used was originally reported as “Trinidad, Beni, Bolivien” and without geographic coordinates (Dirksen, 2002). In the subsequent paper by Dirksen and Böhme (2005), a redescription of *E. beniensis*, the locational data of the holotype was listed again and the coordinates given were based on the city of Trinidad (“11°08’N, 66°10’W”). However, Dirksen and Böhme (2005)’s coordinates are incorrect. The correct latitude should be in the Southern Hemisphere, and the stated coordinates given are not for Trinidad but rather near the city of Riberalta, Beni, Bolivia (ca.

430 km northeast of Trinidad). Interestingly, Wallach et al. (2014) cited this mistake and remarked that the type locality was erroneous; they gave a “correction” [“Trinidad, Beni Dept., NE Bolivia, (14°50’N, 64°54’W)”]. While Wallach et al. (2014) corrected the latitude and longitude for the city of Trinidad, they failed to correct the North-latitude error.

The coordinates for three of the four paratypes (CBF-1675, NKR-1735, and NKR-uncatalogued specimen) listed by Dirksen (2002) and Dirksen and Böhme (2005) are also erroneous. Dirksen (2002) reported the coordinates for specimen CBF-1675 as “(15°29’ / 63°41’)” whereas Dirksen and Böhme (2005) gave the coordinates differently “15°29’N, 63°14’W”. While “S” and “W” were not indicated by Dirksen (2002), Dirksen and Böhme (2005) incorrectly reported the latitude as north and transposed the minutes longitude from 41 to 14. Additionally, the correct department for CBF-1675 is Santa Cruz not Beni. The coordinates for specimen NKR-1735 listed by Dirksen (2002) as “Trinidad (11°08’ / 66°10’)” and Dirksen and Böhme (2005) as “Trinidad (11°08’ N 66°10’ W), Beni, Bolivia” are also both incorrect. Again, the designations of “S” and “W” were not indicated by Dirksen (2002), and Dirksen and Böhme (2005) incorrectly gave the latitude as North; this location is near Riberalta, Beni, Bolivia, ca. 430 km northeast of Trinidad. The coordinates of the uncatalogued NKR specimen were listed as “14°81’ / 65°08’)” by Dirksen (2002) and later “(14°81’N 65°08’ W), Beni, Bolivia” by Dirksen and Böhme (2005); neither are correct. Dirksen (2002) did not indicate “S” and “W”, while Dirksen and Böhme (2005) incorrectly recorded the latitude as North. The coordinates for minutes latitude in both publications were erroneously given as 81, but minutes cannot exceed 60. We determined the correct

Table 1. Scale counts and meristic data for specimens of *Eunectes beniensis* deposited in the herpetology collection of the Centro de Investigación de Recursos Acuáticos in Trinidad, Beni, Bolivia (CIRA).

Specimen	Dorsal	Ventral	Subcaudal	Suboculars	Supralabials	Infralabials
CIRA-945	35/48/33	220	58	2 (in contact with supralabials)	14	18
CIRA-852	36/49/33	225	62	2 (in contact with supralabials)	15	18
CIRA-966	37/48/34	222	61	2 (in contact with supralabials)	14	19

minutes to be 51, based on the location of the road (Ruta Nacional 3) from Trinidad to San Ignacio de Moxos, 9 km (direct) from Río Mamoré to Río Tajamuchi.

Because of numerous errors and inconsistency with locality data by Dirksen (2002) and Dirksen and Böhme (2005), we are reporting corrected coordinates in Table 2 for the holotype and paratypes of *E. beniensis*. These revised coordinates are based, in part, on the following locations: 1) general geographic center of the city of Trinidad, Beni, Bolivia, 2) highway (Ruta Nacional 9) between Ascensión de Guarayos and Trinidad, and 3) highway (Ruta Nacional 3) between Trinidad to San Ignacio de Moxos.

We were able to locate 11 vouchered museum specimens (Table 3) which are important records for Bolivia and specifically the departments of Beni, Santa Cruz,

and Pando. With these specimens it is now possible to provide an updated list of verified, georeferenced occurrence data for this species and enhance knowledge of the species’ distribution. In addition, a field observation (we were able to confirm the identification from several photographs) is also included on the map and in the table. These new and corrected data will aid in a better understanding of the occurrence of *E. beniensis* but also improve the very limited knowledge of this species’ ecology and natural history. Additionally, although the conservation status of *E. beniensis* is currently categorized as Least Concern (IUCN 2022), improved delineations of the true geographic range of *E. beniensis* will aid in future assessments of its status.

The known occurrences of *E. beniensis* appear to be limited to the departments of Beni, Santa Cruz, and Pan-

Table 2. Holotype and paratype specimens of *Eunectes beniensis* locality information from Dirksen (2002) and Dirksen and Böhme (2005) with corrected geographic location data.

Specimen	Dirksen (2002) <i>ad litteram</i>	Dirksen and Böhme (2005) <i>ad litteram</i>	Corrected locality data
AMNH-101924	Trinidad, Beni, Bolivien	Trinidad, Beni, Bolivia (11°08'N 66°10'W)	Bolivia, dept. of Beni, city of Trinidad (14.835°S, 064.899°W)
CBF-1675	Straßenfund, 77 km entfernt von Asunción de Guarayos in Richtung Trinidad (15°29' / 63°41')	on road 77 km from Asunción de Guarayos, direction to Trinidad (15°29'N, 63°14'W), Beni, Bolivia	Bolivia, dept. of Santa Cruz, on road (Ruta Nacional 9) ca.77 road km NW of community of Ascensión de Guarayos (15.479°S, 063.678°W)
NKR-1735	Trinidad (11°08'/66°10'), Beni, Bolivien	Trinidad (11°08' N 66°10' W), Beni, Bolivia	Bolivia, dept. of Beni, city of Trinidad (14.835°S, 64.899°W)
NKR-uncatalogued specimen Currently listed in museum records as MNK-1950	auf der straÙe von Trinidad nach San Ignacio de Moxos, 9 km vom Río Marmoré Richtung Río Tijamuchi (14°81'/65°08'), Beni, Bolivien	road from Trinidad to San Ignacio de Moxos, 9 km from Río Marmoré, direction Río Tijamuchi (14°81' N 65°08' W), Beni, Bolivia	Bolivia, dept. of Beni, on road near Río Tajamuchi (Ruta Nacional 3) ca.12.5 road km W of Río Mamoré (9 km direct) between San Ignacio de Moxos & city of Trinidad (14.85°S, 65.133°W)

Table 3. List of voucher specimens of *Eunectes beniensis* collected from Bolivia based on published literature and museum data (including new records) as well as an additional field observation. Coordinates for UMMZ-56863, CIRA-852, and CIRA-966 are based on textual descriptions for the collection location and coordinates were based on the approx. center of the locations with the centroid coordinates 0.5 km in relation to the perimeter. Coordinates for holotype and paratype specimens incorporate corrected locality data (see Discussion). Abbreviation/coding for Museo de Historia Natural “Noel Kempff Mercado (MNK) follows Sabaj (2020). All updated geographic location data listed in decimal degrees.

Specimen	Date collected	Department	Locality	Latitude, longitude
CIRA-945	30 June 2022	Beni	Ca. 32.0 road km SW of community of San Ramón	13.4458°S, 64.8245°W
CIRA-852	April 1999	Beni	City of Trinidad, Barrio Chaparral area	14.829°S, 64.909°W
CIRA-966	16 May 2012	Beni	Laguna Suárez area ca. 4.0 km SE of city of Trinidad	14.875°S, 64.874°W
AMNH-101924	30 Aug. 1964	Beni	City of Trinidad	14.834°S, 64.899°W
UMMZ-56863	No data	Pando	Manoa, extreme NE corner of Bolivia	09.671°S, 65.445°W
CBF-1675	30 Oct. 1994	Santa Cruz	On road (Ruta Nacional 9) ca. 77 road km NW of community of Ascensión de Guarayos	15.479°S, 63.677°W
MNK-1735	11 July 1998	Beni	City of Trinidad	14.834°S, 64.899°W
MNK-1950	28 July 1998	Beni	On road near Río Tajamuchi (Ruta Nacional 3) ca.12.5 road km W of Río Mamoré between San Ignacio de Moxos and city of Trinidad	14.850°S, 65.133°W
MNK-5537	10 March 2016	Santa Cruz	Ruta Nacional 9, ca. 44 road km NW of community of Santa Maria	15.437°S, 63.710°W
CBF-2552	04 Jan. 2009	Beni	No data	—
CBF-4227	No Data	Beni	Near town of San Borja, José Ballivián province	14.847°S, 66.767°W
Field obs.	23 June 2018	Santa Cruz	Crossing road (Ruta Nacional 39) near San Pablo River	17.027°S, 61.861°W

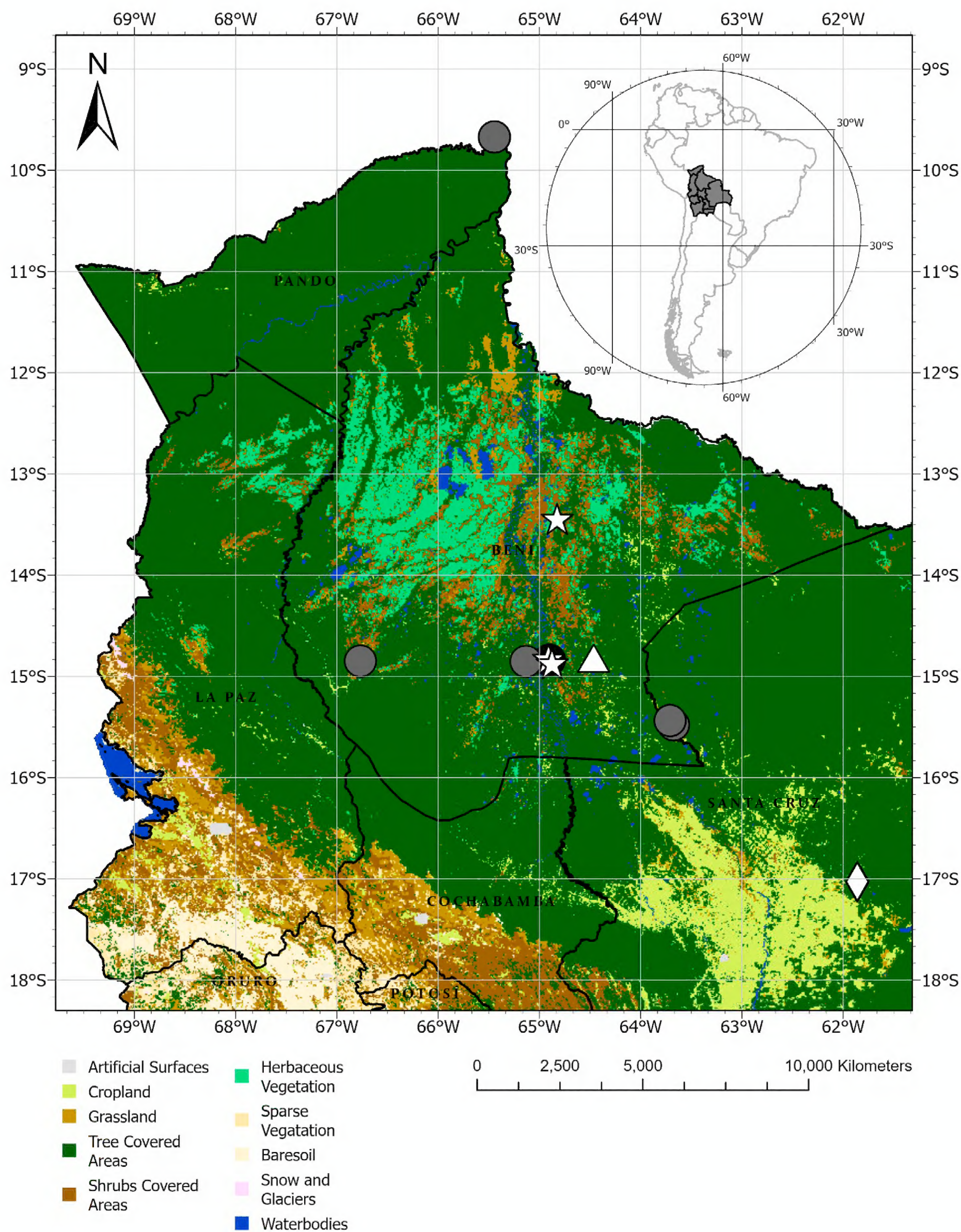


Figure 4. Distribution map of *E. beniensis* and Bolivian land-cover types. Solid circles: previous vouchered museum specimens, grey (○) indicates single specimen, black (●) represents multiple specimens in close proximity. Open stars (☆): new vouchered specimens reported herein. Open triangle (△): non-vouchered specimens reported by De la Quintana et al. (2011, 2017). Open diamond (◇): field observation. Specimen CBF-2552 was not included due to lack of specific locality information.

do in the Beni floodplains and Amazonian region of Bolivia (Fig. 4). Compared to other *Eunectes* species that occur in Bolivia and surrounding countries (i.e. *E. murinus* and *E. notaeus*), *E. beniensis* appears to have a less extensive distribution (Wallach et al. 2014; Reyn-

olds et al. 2018; Uetz et al. 2022). Muñoz et al. (2016) and Reynolds et al. (2018) commented that *E. beniensis* may also occur in nearby areas of Brazil; however, as to our knowledge, no voucher specimens have been collected outside the borders of Bolivia. Neverthe-

less, based on a specimen from Manoa, department of Pando, in the extreme northeastern corner of Bolivia (at the confluence of Rio Abuna and Rio Madeira) and directly adjacent to the Brazilian state of Rondônia, it is highly probable *E. beniensis* occurs in parts of Brazil. Additionally, our results indicate that the distribution of *E. beniensis* is probably concentrated in the tri-border area of the departments of Beni, Santa Cruz, and Cochabamba but also likely occurs throughout northern Beni, the department of Pando, parts of La Paz, as well as farther south than previously documented for the department of Santa Cruz (Fig. 4). Furthermore, we agree with Dirksen and Böhme (2005) in that *E. beniensis* is parapatric or sympatric with *E. murinus* in Bolivia. For example, De la Quintana et al. (2018) documented a female *E. murinus* at the same study site as several *E. beniensis* in southeastern Beni. Also, Dirksen (2002) noted several *E. murinus* in extreme eastern Beni along the border with Brazil.

It is probable that these two species occupy similar niches with similar habitat requirements and preferences. Our results suggest that *E. beniensis* is distributed in areas of landscape mosaics that include inland freshwater wetlands and a mixture of herbaceous, shrub, and forest cover. Interestingly, these mosaics are most prevalent in the department of Beni but are also common, albeit across smaller areas, in other parts of Bolivia and South America; these mosaics appear to be an important landscape-level characteristic. While the geographic range of *E. notaeus* in Bolivia is restricted to the Paraguay river drainage of the Pantanal in the extreme southeastern region of the country, *E. murinus* and *E. beniensis* occurs in Bolivia within several Amazon river sub-basins (Ziesler and Ardizzone 1979; Henderson et al. 1995; Dirksen 2002; Kershaw et al. 2013).

It is likely that *E. beniensis* is more common and widespread than museum and collection records reflect, probably due to the aforementioned difficulties associated with collecting and preserving this species. However, it is imperative to note that more specimens are needed to fully delimit and understand the distribution of *E. beniensis* in its entirety across Bolivia and possibly into neighboring countries. Additionally, research efforts and investigation in the region of southeastern Bolivia—a potential contact zone between *E. beniensis* and *E. notaeus*—is also vital. This will greatly improve not only knowledge of this poorly studied species but also future conservation and management of *E. beniensis* populations and habitat.

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Authors' Contributions

Conceptualization: RLP, AVC, CBE, LRR. Data curation: RLP, AVC, CBE, LRR. Visualization: AVC, CBE. Writing –original draft: RLP, AVC. Writing – review and editing: RLP, AVC, CBE, LRR, PQ.

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